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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

INVESTIGATIONS AT THE NUTRITION LABORATORY OF THE CARNEGIE INSTITUTION OF WASHINGTON, BOSTON, MASSACHUSETTS[1]

CONTRARY to popular opinion the researches of the Carnegie Nutrition Laboratory do not follow for the most part the conventional lines of "nutrition investigations" with special emphasis upon the economic and sociological phases of the work. The admirable facilities and equipment of the United States Department of Agriculture fortunately make this unnecessary. The Carnegie Laboratory is, however, an outcome of the national nutrition investigations, for the late Professor W. O. Atwater, who was a pioneer in nutrition investigations of this country, wisely devoted a part of the government appropriation for nutrition investigations to an abstract study of the physiological effects of various nutrients upon the human body. This work was carried out in the chemical laboratory of Wesleyan University, Middletown, Conn., and resulted in the construction of a special form of apparatus for studying both the respiratory products and the direct heat production of man, an apparatus properly designated by Professor Atwater as a "respiration calorimeter." Subsequently the board of trustees of the Carnegie Institution of Washington authorized the construction of a special laboratory for similar research in Boston.

It was believed that the appropriation for this laboratory, for a time at least, could best be subdivided into three main

[1] An address delivered before the department of chemistry at Vassar College, Poughkeepsie, New York, on May 10, 1915.

categories: First, the development of new apparatus and technique, thus insuring progress in technical lines; second, the accumulation of normal physiological data regarding the metabolism and many physiological factors of both men and animals, such research being needed to supplement the insufficient data secured in previous investigations; and third, the comprehensive, critical study of certain pathological cases, notably diabetics. In connection with the first of these lines of work there has been not only the development of a large amount of apparatus—for the greater part of the apparatus used in the nutrition laboratory has been there devised and constructed—but also an extensive comparison of other methods in regular use, to determine their degree of accuracy and applicability.

The laboratory building is of special construction, the main feature being the large room devoted to calorimetric researches. With so delicate an apparatus as the calorimeter, the effect of temperature environment is profound, and consequently this room is provided with heating and cooling devices by which the temperature may be held constant. Researches with this apparatus may therefore be conducted at any time of the year without regard to the prevailing temperature.

As at present equipped, the calorimeter laboratory has four calorimeters, all of which may be used for studying the heat production of the human body. Of these the bed calorimeter has been most extensively used for studying normal men and women as well as in a long series of experiments with severe diabetics. The inner chamber of this apparatus is copper-walled and about 7 feet long and 3 feet wide, varying in height from 2 feet at the foot to about $3\frac{1}{2}$ feet at the head. The subject, lying comfortably on a mattress, is slid into this chamber and the opening closed with a large piece of plate glass, the closure being made airtight by sealing with wax. The ventilating current draws the air from this chamber, forces it through sulphuric acid to remove the water vapor given off by the lungs and skin of the subject, and then through soda lime to remove the carbon dioxide. After pure oxygen has been added to replace that used, the air returns to the chamber to be rebreathed by the subject. By weighing the soda lime containers at the beginning and end of the experiment and metering the oxygen admitted, we have a direct measure of the carbon dioxide produced and the oxygen consumed. This is the respiratory feature of the apparatus.

The method of measuring the heat production is of particular interest. The inner chamber or copper box is surrounded by several layers of material which provide good insulation. Outside of this copper box are two supplementary walls, the first of zinc and the second of a one-inch layer of cork. These walls are in each case three inches from the inner wall, providing two dead air spaces between the copper and the zinc and the zinc and the cork, respectively. The outside of the calorimeter is finished with compo board. Thus, the apparatus is of the refrigerator type of construction, effectually preventing heat radiation. In winter, houses are heated by passing hot water through pipes. This small chamber, or little house, would, unless cooled, become uncomfortably warm from heat given off by the body, and provision for cooling is made by passing a current of cold water through the chamber in fine serpentine copper pipes. The temperature of the water is recorded as it enters and leaves the chamber. If the total weight of water leaving the apparatus is measured the heat brought away is readily computed by multi-

plying this weight by the temperature difference.

The chair calorimeter is of a different shape, although primarily of the same construction. In the chair calorimeter, the subject sits in a comfortable arm chair, the walls of the chamber being of such a form as to give a minimum amount of air space about the body. The total volume of air space in the bed calorimeter is 950 liters, and in the chair calorimeter 1,500 liters. Neither apparatus, however, permits long experiments.

A third calorimeter has been built which is long enough for a man to lie down in, and yet high enough for him to stand up; the form of the chamber also permits the installation of a bicycle ergometer inside the chamber for muscular work experiments. The volume of air space in this apparatus has been limited to 3,500 liters. By means of a double port-hole it is possible to put in or take out food or other material without loss of air. The subject can live in this apparatus as long, if not longer, than in the chamber at Wesleyan University, Middletown, Conn., the longest experiment with that apparatus covering 13 days and 14 nights. Thus far no continuous calorimeter experiments of any considerable length have been made in the Nutrition Laboratory.

Finally, to provide a calorimeter especially designed for severe muscular work with a bicycle ergometer, treadmill, or endless ladder, a calorimeter has been built with provision for installing any one of these muscular work appliances. Owing to the great amount of heat that will be developed in such experiments, special heat-absorbing pipes and temperature measuring apparatus have been necessary.

With the respiration calorimeter it is possible to measure simultaneously the carbon dioxide and water vapor produced, the oxygen consumed, and the heat given off by a man. These factors taken not only individually, but also together, give most important data for the computation of the character and amount of the interchange of material inside of the body due to vital processes.

Fortunately it was found that the long and costly twenty-four-hour calorimeter experiments could be in part replaced by shorter experiments, in which only the carbon-dioxide production and oxygen consumption were studied, by means of a respiration apparatus devoid of calorimetric features and that this type of short experiment could be used in the study of many problems. An apparatus was devised by which a subject lying on a bed could breathe through a mouth- or nosepiece, and determinations of the carbon dioxide produced and the oxygen consumed could be made in periods as short as 15 minutes. These experiments have been carried out very rapidly and at relatively slight expense, and have been of great value in giving us a large amount of important physiological information. In recent years, the calorimeters have also been used for short experiments, these being from one to two hours long; indeed, the research on diabetes, which has been in progress in the Nutrition Laboratory for the past six years, has relied for the most part on calorimeter experiments of from one and one half to two hours' duration.

The influence of muscular activity upon the production of carbon dioxide and heat is enormous. When a subject is sound asleep, quiet and without food in the stomach, we have the minimum basal metabolism. The influence of sleep has only been tardily recognized, and the majority of physiologists are inclined to speak of basal metabolism as that obtained in the early forenoon, when the subject is lying

quietly without breakfast, but not asleep. If the subject is sitting up, the metabolism is increased, and if he is doing work it is increased in proportion to the amount of work. The approximate normal output of carbon dioxide and heat for a man of average weight with varying conditions of muscular activity is shown in Table I. By means of this table one may calculate the approximate carbon dioxide and heat output of a man during twenty-four hours. (See Table II.)

TABLE I

Average Normal Output of Carbon Dioxide and Heat from the Body

Conditions of Muscular Activity	Average Quantities Per Hour: Carbon Dioxide, Gm.	Heat Cals.
Man at rest, sleeping	25	65
Man at rest, awake, sitting up	35	100
Man at light muscular exercise	55	170
Man at moderately active muscular exercise	100	290
Man at severe muscular exercise.	150	450
Man at very severe muscular exercise	210	600

TABLE II

Average Daily Output of Heat of a Man at Light Muscular Work

Daily Program	Heat Output
At rest, sleeping, 8 hours, 65 calories per hour	520
At rest, awake, sitting up, 6 hours, 100 cal. per hour	600
Light muscular exercise, 10 hours, 170 cal. per hour	1,700
Total output of heat, 24 hours	2,820

It is of no avail to make investigations in pathology unless we have a suitable base line or ground for comparison, and in practically all our clinical studies we have had to supply the deficiency in normal data. While the temptation is at times very great to carry out a series of experiments which will most certainly promise striking results, we have felt constrained to plod along and secure fundamental basal values, and thus contribute steadily to the knowledge of the physiology of man. To do this, and to secure information as to the influence of variations in height, age, weight and sex of normal individuals, we have studied 90 or more normal men, and nearly as many normal women, and have secured approximate basal values for these individuals. Studies have likewise been made of athletes and vegetarians. For the most part these observations were made with the small respiration apparatus and not with the calorimeters; indeed, at times as many as four respiration apparatus have been used simultaneously in our large calorimeter room, in studying the metabolism of four individuals.

Two factors that affect normal metabolism more than any others are the ingestion of food and muscular activity. In Table I., the somewhat vague terms of "light," "moderately active," "severe" and "very severe" muscular work were used. These really have no quantitative meaning, and it is necessary for us to measure accurately the amount of mechanical work performed when studying the metabolism of a person doing severe muscular work. For this purpose several forms of bicycle ergometer have been used by means of which the rider transforms a certain amount of muscular work into heat. The ergometer may be placed inside a respiration calorimeter, or the subject may be connected with a suitable mouthpiece to a simple respiration apparatus. The series of studies on this apparatus have proved most illuminating, and show that the human body is really a very efficient engine. While in certain cases as much as 35 per cent. of the total energy transformed during muscular work may be transferred to the pedals of the ergometer, there to be transformed into

heat, the average values obtained were those given in Table III.

TABLE III

Experiments on Bicycle Riders (Calories per Hour)

	Resting	Working	Work Done	Efficiency, Per Cent.
J. C. W. (college athlete)	112	339	49	21.6
B. F. D. (college athlete)	106	318	45	21.2
A. L. L. (untrained)	—	326	46	20.8
E. F. S. (untrained)	?	399	51	18.1
N. B. (professional rider)	92	619	112	21.3
		471	79	20.8
		401	65	21.0
		382	60	20.7

The figures in Table III. shed a most interesting light on the question of training. It has commonly been supposed that when a person is trained, the muscles become more effective and consequently there is a greater production of work for the same expenditure. Here we find that in the first place the two men, A. L. L. and E. F. S., who were wholly untrained, and indeed wholly unfamiliar with the bicycle, accomplished as much work as did the college athletes, J. C. W. and B. F. D., with an efficiency very little less than that of the first two. When we examine the results obtained with the professional bicycle rider, Mr. Nat Butler, we find that he was able by virtue of his strength to accomplish a very great deal *more* work than any of the other men, but as a matter of fact his *efficiency* was not materially greater than that of the college athletes, or, indeed, the untrained men.

In order to produce this heat in the body there must have been vigorous combustion, either of body substance, in case the subject did not have food enough, or of food material previously eaten. We have found as a result of a large number of experiments that a man at rest, doing no visible external muscular work, requires not far from 2,000 calories for maintenance during twenty-four hours. It will be seen that in three hours Mr. Butler produced nearly this amount when at severe muscular work; consequently he must have burned up in these three hours as much material as would ordinarily be burned by a subject at rest in twenty-four hours. On this same basis, he would need three meals every three hours or one square meal an hour.

A new series of muscular work experiments is in progress in the Nutrition Laboratory under the direction of Professor H. M. Smith in which the subject walks on a specially-designed treadmill at varying rates of speed, breathing through a mouthpiece into a respiration apparatus which measures the carbon-dioxide excretion and the oxygen consumption. As a result of this investigation it has been found that in walking on a level road at a moderate gait (70 to 80 meters per minute) there is an increase in the heat production for each kilogram of body weight moved forward one meter, which is equivalent to about 0.5 small calorie. With an increase in velocity the energy expenditure is rapidly augmented and during running may become 60 per cent. more per unit of weight transported than that of the subject walking at a moderate rate. Studies are also being made with this treadmill in which the subject walks on an incline, the work of ascent thus being added to the work of walking on a level.

In this investigation, which is elaborate, a large number of simultaneous measurements have been attempted. In addition to measurements of the carbon-dioxide excretion and the oxygen consumption, we

have simultaneously recorded the total distance walked, the number of steps, the inclination of the treadmill and the total height of the body movement. By attaching a cord to the shoulders and connecting it with a pointer, a record of the up-and-down motion of the body with each step is made, and by a multiplying device the total sum of the upward motions of the body are also recorded, thus giving the total height to which the body is raised during the period of walking, for in walking on a level plain, an individual raises his body from 1 to 1½ inches each step.

Connected with the ventilating air current of the respiration apparatus is a delicately-counterpoised bell or gas-holder, which rises and falls with each respiration. By means of a pointer attached to the counterpoise of this bell, a graphic record of the type of respiration is obtained. A multiplying device attached permits the measurement of the total amount of air actually passing through the lungs independent of the ventilation of the respiration apparatus itself. This graphic record of the ventilation of the lungs likewise records the respiration rate. Finally, by means of electrodes attached to the chest, the pulse rate of a walking man is photographically recorded with a string galvanometer or an oscillograph.

The intimate relationship between pulse-rate and the total energy output has been the subject of special study, and the pulse-rate, the respiration-rate, and particularly the body temperature have received especial attention in our several lines of investigation. The distribution of a number of delicate thermometers in different parts and cavities of the body has shown that when the temperature deep in the body trunk undergoes its regular daily rhythm, these fluctuations in temperature are accompanied by similar fluctuations in all the other thermometers, and that while the absolute temperatures in different parts of the body are unlike, the fluctuations in temperature are essentially the same throughout the whole body.

It has long been known that when food is eaten the body activities are considerably increased. This is particularly the case when the food consists of protein material. The exact cause of this increase has long been the subject of much discussion. On the one hand it was believed that this was due to the work of digestion in the digestive tract; on the other hand, that it was due to an excess heat production caused by the splitting off and combustion of portions of the protein molecule. A long series of investigations in the Nutrition Laboratory has shown that when peristaltic stimuli, such as saline purgatives, were used and careful control tests made, the movements of the digestive tract did not measurably increase the metabolism. When dogs who had deficient digestive capacity were fed large amounts of meat, in spite of the excess of undigested residue, the metabolism was not augmented. Evidence has been accumulated which shows that the acid products of cleavage in the processes of digestion are probably the chief factors causing this increase in metabolism, which was explained by the direct stimulus of the cells to a greater activity.

One of the most interesting researches developing from the comparison of methods for studying the respiratory exchange has been the importance of knowing physiologically the exact composition of outdoor air. Every person is continually taking air into the lungs. Many technical methods for determining the amount of oxygen thus consumed involve some assumption as to the exact composition of the normal outdoor air inhaled. An investigation lasting over three years, in which daily analyses of

outdoor air were made by Miss Alice Johnson, proved conclusively that the percentage of carbon dioxide and oxygen in uncontaminated outdoor air remained constant throughout the entire year, irrespective of wind direction and temperature. Specimens of normal air secured at numerous places on the Atlantic Ocean and on the top of Pike's Peak showed the same remarkable uniformity. By this study we were provided at one and the same time with a standard for testing all gas-analysis apparatus and definite knowledge regarding the composition of inspired air, thus doing away with the necessity for the innumerable analyses that otherwise would be essential.

The investigations on diabetes in conjunction with Professor Elliott P. Joslin have shown in the first place that during severe diabetes there is a distinct increase in the basal metabolism of the patients. It has also been shown that this increased metabolism in diabetes is due to the fact that with the abnormal breaking down of food materials in the body of the diabetic there is developed an excessive amount of acid, chiefly B-oxybutyric acid, which directly stimulates the cells to a greater activity. With treatment reducing the acidity and particularly with the new, remarkable Allen treatment this increased metabolism entirely disappears.

In addition to the study of diabetics, a number of other projects have received consideration at the Nutrition Laboratory. Among these are the study in conjunction with Dr. F. B. Talbot of the metabolism of normal and atrophic infants and of infants in the first hours of post-natal life. The importance of knowing the energy requirements and the character of the combustion in the body of the new-born infant has justified an extended research on this subject in which we have studied over 100 infants within the first few hours after birth. The new-born babies were taken from the hospital immediately after birth, placed in the respiration chamber and there studied for several hours, very careful records of the carbon dioxide produced and the oxygen consumed being made. The observations on atrophic hospital infants have supplied values of particular significance in interpreting a number of so-called "physiological laws." Indeed, one of the best methods of studying physiology is to study abnormal physiology.

In connection with the respiration experiments on infants a knowledge of the exact degree of repose of the subject is of importance. I have already shown the enormous influence of severe muscular activity upon the metabolism of man, and it is evident that if, in securing normal data regarding infants, to be subsequently used for comparison with pathological cases, we do not take cognizance of the influence of even minor muscular activity, we are liable to great error. Thus, it would be wholly irrational to compare the metabolism of a normal, healthy infant, but moving and restless, with that of a weak, emaciated infant lying perfectly quiet. Nor is it sufficient to supplement our measurements of the respiratory exchange by records of ocular observations of the activity, for experience quickly showed us that these were wholly inadequate. A method has therefore been devised for automatically recording the muscular activity. The crib in which the baby is placed rests at one end on two frictionless steel points. The other end is supported by a spiral spring having a rubber tube about it. As the infant moves, the air inside of the rubber tube expands or contracts and by means of the air transmission any changes in this tension may be recorded with a delicate tambour and writing point. This adjustment may be so

delicate that even the slight change in the center of gravity of the infant due to respiration, muscular tremors, or movements of the hand or fingers are immediately recorded. These graphic records are now an absolute essential of all metabolism experiments in our laboratory, and unless the records of activity are approximately alike, no use is made of the experimental periods for comparison purposes. Precisely this same principle applies not only to babies, but to the observations on animals, such as dogs, ducks, geese and guinea pigs. Arrangements are made for securing similar records for men and women lying in the bed calorimeter or on a couch connected with the respiration apparatus.

A large number of observations have been made on normal animals, chiefly dogs, rabbits, and more recently geese. The influence of partial inanition, of temperature environment, of the ingestion of various kinds of foods, and of living in an atmosphere containing a high percentage of oxygen have all been the subject of researches which are more or less nearly complete. It was obviously necessary to develop special apparatus and special technique for these researches and in all instances the observations included a large number of control tests of the apparatus and experiments with control animals.

While many, if not indeed the majority of the researches in the Nutrition Laboratory may be considered as of an abstract, scientific nature, one research certainly has far-reaching, practical bearings, namely, the investigation of the influence of alcohol upon the metabolic, neural and muscular processes. The laboratory is at present engaged in an extended program of research on these vexed problems and not only is the influence of alcohol upon the metabolic processes studied with the special equipment of the laboratory, but a special laboratory has been constructed for the study of the influence upon the neural and muscular processes. The equipment of this special laboratory includes the exceedingly ingenious string galvanometer of Einthoven for measurements of the pulse and heart, the faradic stimulus apparatus of Kronecker and of Martin, and particularly the apparatus of Dodge. In the past year the psychological phases of the work have been further extended by Professor Walter R. Miles to include observations on professional typists, with a most careful analysis of the movements and reactions incidental to typewriting. A program for the complete research has been prepared and submitted to a large number of European and American scientists for comment, and the studies will be planned in accordance with this program. Such an elaborate program emphasizes the value of being able to conduct researches continuously for a series of years and thus accumulate definite and authoritative data with regard to problems that have heretofore been studied for the most part in a desultory manner.

Perhaps the most ambitious undertaking of the laboratory thus far has been a recent study of prolonged fasting. Just prior to the establishment of the Carnegie Nutrition Laboratory a special fund was appropriated by the trustees of the Carnegie Institution of Washington for the study of fasting at Wesleyan University, Middletown, Conn. Upon the basis of this investigation plans were made for studying a fasting subject over a long period, but it was not until 1912 that opportunity arose for satisfactorily conducting such a research. The subject fasted for a period of thirty-one days, taking absolutely no food and drinking but 900 c.c. of distilled water per day. The subject was also studied during a short preliminary period and during a three-day realimentation period. During

[NUTRITION LABORATORY OF THE CARNEGIE INSTITUTION OF WASHINGTON, BOSTON, MASSACHUSETTS]

METABOLISM CHART OF A MAN FASTING 31 DAYS

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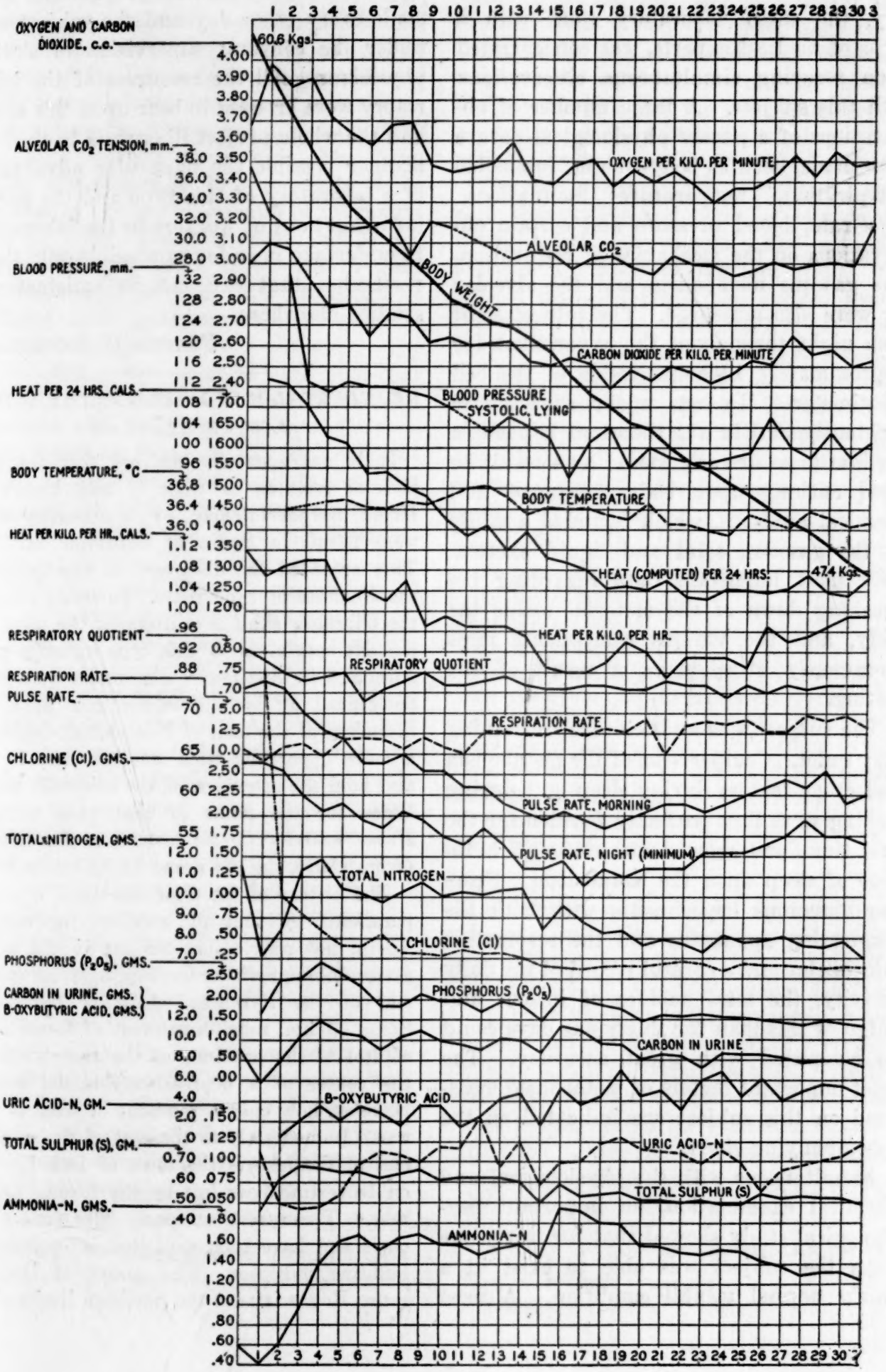

the sojourn of the subject in the laboratory, the entire laboratory staff, with a corps of medical experts, was concentrated upon securing simultaneous observations with this subject. A large number of observations of a purely physiological nature were made, such as body-weight, insensible perspiration, temperature fluctuations, pulse-rate, blood pressure and certain observations on the mechanics of respiration. The gaseous metabolism and the alveolar air were also measured. The subject slept each night throughout the experiment for approximately 10 hours inside of the bed calorimeter. He was under surveillance constantly and it was therefore impossible for him to secure any food. As a result he lived entirely upon body substance, and chemical analyses, which included a study of the gaseous, solid and liquid excreta, gave most important data regarding the breaking down of the material inside the body, and the various components most strenuously attacked as a result of the fasting.

The subject was an ideal one, remaining very quiet. Comparisons of the metabolism and other factors during sleep and during waking were thus perfectly feasible for the first time, and showed the profound influence of sleep upon the metabolism. From the numerous experiments with both the respiration apparatus and the respiration calorimeter and a careful record of the daily activity, the total balance of income and outgo of this man for thirty-one days could be computed with great accuracy. The most important factors of metabolism measured on this subject are indicated on the accompanying chart.

Simultaneous with the physiological and chemical examination, an important psychological study showed that for thirty-one days the subject was able to exist in a fairly normal mental condition. A most rigid and careful clinical examination was made every other day and the subject was under the constant supervision of skilled physicians. All the resources of the laboratory were brought to bear upon this study and the whole project illustrates in the best manner possible the particular advantages of a laboratory of this type and the peculiar obligations of workers in the laboratory to undertake in so far as possible only those researches that can not be satisfactorily studied elsewhere.

Francis G. Benedict

NEANDERTAL MAN IN SPAIN: THE LOWER JAW OF BAÑOLAS

It is not generally realized that the first skeletal remains of what is now known as *Homo neandertalensis,* or Mousterian man, were found in Spain at Gibraltar in 1848. This preceded the discovery in the valley of the Neander by nine years. In many respects the Gibraltar skull is still one of the most important specimens of this type of early man. Although its distinctive characters were early recognized by both Falconer and Busk, the discovery of the man of Neandertal coming at a more opportune time was the first to win and hold the attention of the scientific world: hence for the name of that race we have *Homo neandertalensis* instead of *H. calpicus* (from Calfé, the old name for Gibraltar).

The history of the Gibraltar skull is almost paralleled by that of another discovery in Spain, not near Gibraltar but in the northeasternmost province, Gerona, near the eastern end of the Pyrenean chain of mountains. Some 23 km. north-northwest of Gerona, the capitol of the province of the same name, in the center of a depression lies the lake of Bañolas, now only a remnant of what it once was. Immediately to the east of the southern end of the lake is the town of Bañolas built on travertine beds left by the former greater lake. These rest on early Quaternary red clays and have been exploited extensively for building purposes. The quarry of Don Lorenzo Roura is near the northern limits of the

town in what is called "Llano de la Formiga." Here in April, 1887, he encountered a human lower jaw embedded in the hard travertine at a depth of from four to five meters. Fortunately Roura left the fragile jaw, almost complete, in its stone matrix and turned the block over to a Bañolas pharmacist, Don Pedro Alsius, who undertook the preparation of the specimen by the careful removal of the matrix from the bone. The relic is still in the private collection of Alsius, or rather of his family, for he died early in 1915. Although he published nothing concerning the specimen, Alsius recognized its archaic character. The first printed notice seems to have been that in "Anuari del Institut d'Estudis Catalans," Barcelona, 1909, by Professor Manuel Cazurro. Another note by Professor E. Harlé appeared in 1912 in the *Boletin del Instituto Geológico de España* (Madrid). Now comes an exhaustive study entitled "La Mandibula Neandertaloide de Bañolas," by Professors E. Hernandez-Pacheco and Hugo Obermaier.[1]

On account of its fragile character no attempt has been made to separate the lower jaw wholly from its matrix. Its inner surfaces are therefore not accessible. The outer surfaces including a full set of sixteen teeth are laid bare. The bone is of the same color as the matrix and highly fossilized. The right side is fairly well preserved. The condyloid process however is entirely gone. The anterior portion of the coronoid process is nearly complete; but its highest point can not be definitely fixed. A small piece is missing from the angle at the junction of the horizontal with the ascending ramus, but its negative is so well preserved by the tufa that the gonion can be determined with accuracy.

The left half of the jaw was broken in seven pieces when discovered. These have been successfully united. But owing to a very early break the whole left half is shoved outward and backward to a slight degree, a defect which can not be remedied. The left ascending ramus is not in so good a condition as the right. While the coronoid and condyloid processes are missing, the transverse diameter of the latter can be measured because of the tufa negative. Nearly the whole of the condyle lies inside the plane of the outer surface of the ascending ramus if extended, as is the case with the lower jaw of La Chapelle-aux-Saints.

The neck of the condyle is short; the coronoid process, low and blunt as seen in the nearly intact right ramus. The ascending branches are relatively low and broad. The body of the lower jaw is also low but robust. The chin is at least rudimentary if not wholly lacking; the angle of symphysis is 85°, placing the man of Bañolas in the same class with that of La Ferrassie. In some Neandertal examples the absence of chin is more pronounced and the angle of symphysis correspondingly greater as seen in the following table from Boule:

Recent man (individual variations)..	57° to 93°
Lower jaw of La Ferrassie	85°
Lower jaw of *Bañolas*	85°
Lower jaw of La Naulette	94°
Lower jaw G and H of Krapina	99°
Lower jaw of La Chapelle-aux-Saints.	104°
Lower jaw of Mauer	105°
Lower jaw of Malarnaud	105° to 110°
Lower jaw of Spy	106° to 111°
Lower jaw of the Gorilla	105°
Lower jaw of the Chimpanzee	115°
Lower jaw of the Orang	124°

The lower jaw of Bañolas belonged to a male, who had reached the age of about forty years. Morphologically it falls within the Neandertal group, being the second discovery of this type in Spain. Unfortunately it was associated neither with other skeletal remains nor with artifacts. The travertine and the lower jaw itself are undoubtedly Pleistocene. If not so archaic as the Gibraltar skull, it might well be as old as the remains from La Ferrassie, which were associated with a typical Mousterian industry.

GEORGE GRANT MACCURDY

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[1] "Comisión de Investigaciones Paleontologicas y Prehistoricas," memoria numero 6, Madrid (Hipodromo), 1915.

CALIFORNIA MEETING OF THE GEOLOGICAL SOCIETY OF AMERICA

The business sessions of the summer meeting of the society are to be held as planned at the University of California and Leland Stanford Junior University, August 3–5, 1915, in affiliation with the American Association for the Advancement of Science.

The sessions of Tuesday and Wednesday, August 3 and 4, will be held at the University of California and that of Thursday, August 5, will be held at Stanford University. Morning sessions at Berkeley will begin at 10 o'clock; Stanford University, at 10:30 o'clock. Afternoon sessions open at 2 o'clock. Train leaves San Francisco 9 A.M., arriving Palo Alto at 9:54.

The society's subscription dinner will be held at the Engineers Club, San Francisco, at 7 o'clock on the evening of Wednesday, August 4. The price is $1.50 per plate. Early notice of intention to participate in the dinner should be sent to the secretary of the Cordilleran Section, Mr. J. A. Taff, 781 Flood Building, San Francisco.

Excursions, August 6, to Point Reyes Station, Marin County, for an examination of the San Andreas earthquake rift and to Mussel Rock, San Mateo County, for an examination of Pliocene strata, the type section of Merced formation and the post-Tertiary deformation of the coast.

August 7 to Santa Cruz for an examination of uplifted marine terraces.

August 9 and 10 (with the Paleontological Society) to Mount Diablo for an examination of the Mount Diablo overthrust and the succession of Tertiary strata and to Walnut Creek.

August 11 and following days, to Yosemite with F. E. Matthes and E. C. Calkins.

The Shattuck Hotel at Berkeley has been selected for the hotel headquarters where rooms may be had from $1.50 up. Reservations should be made in advance. For a complete list of hotels with rates see SCIENCE, Vol. XLI., No. 1068, June 18, 1915, page 893.

Information regarding railroad routes and rates from the east may be gathered from SCIENCE, Vol. XLI., No. 1069, June 25, 1915, page 935.

The principal features of the program are the following symposia:

On Erosion and Deposition in Arid Climates, led by H. E. Gregory.

On Diastrophism of the Pacific Coast, led by Andrew C. Lawson.

On Petrological Problems of the Pacific Area, led by R. A. Daly.

On Seismology of the Pacific Coast Region.

On Ore Deposits, led by C. F. Tolman.

The first four will be held at the University of California and the last at Leland Stanford Junior University. The afternoon session of Wednesday will be devoted to seismology.

The following titles have been submitted thus far, others may be included in the daily program.

John D. Clark (introduced by C. F. Tolman, Jr.), "The Rôle of Colloidal Migration in Ore Deposits" (15 minutes).

William Herbert Hobbs, "Origin of the Basins within the Hamada of the Libyan Desert" (20 minutes).

William Herbert Hobbs, "Limited Effective Vertical Range of the Desert Sand-blast, Based upon Observations made in the Libyan Desert and in the Anglo-Egyptian Sudan" (20 minutes).

J. C. Jones (introduced by J. C. Merriam) "Origin of the Tufas of Lake Lahontan" (20 minutes).

Andrew C. Lawson, "The Profiles of the Desert" (30 minutes).

George D. Louderback, "Structural Features of the Tsin Ling Shan" (60 minutes).

J. C. Ray (introduced by C. F. Tolman, Jr.), "Examples of Successive Replacement of Earlier Sulphide Minerals by later Sulphides at Butte, Montana" (lantern slides, 15 minutes).

A. F. Rogers (introduced by C. F. Tolman, Jr.), "Sericite, a Low Temperature Hydrothermal Mineral" (lantern slides, 20 minutes).

C. F. Tolman, Jr., "Bajadas of the Santa Catalina Mountains, Arizona" (20 minutes).

C. F. Tolman, Jr., "Chemical Interpretation of Certain Data Furnished by the Microscopic Investigation of Ores" (lantern slides, 30 minutes).

Harry O. Wood (introduced by A. C. Lawson), "On a Possible Causal Mechanism for Heave Fault-slipping in the California Coast Range Region" (30 minutes).

S. W. Young (introduced by C. F. Tolman, Jr.), "Certain Chemical Factors Governing Secondary Enrichment" (45 minutes).

Inasmuch as the secretary of the society is now leaving on an expedition which will keep him out of the country for about three months, requests for further information regarding the summer meeting of the society should be sent to Mr. Taff at the address given above. Additional titles of papers to be presented at the meeting should likewise be sent to him direct.

The summer meeting of the Paleontological Society will be held at Berkeley and Stanford University in affiliation with the Geological Society on the same dates. Details of the program and excursions may be learned from Dr. R. S. Bassler, U. S. National Museum, Washington, D. C., or Dr. J. C. Merriam, Leland Stanford Junior University, Stanford University, California.

The meeting of Section E of the American Association for the Advancement of Science will be merged in that of the Geological Society of America. Members of the section are cordially invited to attend the sessions and take part in the open discussions.

EDMUND OTIS HOVEY,
Secretary
AMERICAN MUSEUM OF NATURAL HISTORY,
NEW YORK

SCIENTIFIC NOTES AND NEWS

DR. RICHARD H. CREEL, of the United States Public Health Service, has, after first declining on account of his health, now accepted the appointment as health commissioner of the city of Boston.

THE American Ambassador to France presented on June 24 the American Geographical Society's gold medal to M. Vidal de Lablache, the distinguished French geographer.

THE British Institution of Mining Engineers has awarded its medal this year to Dr. J. S. Haldane, F.R.S., in recognition of his work on the causes of death in colliery explosions and other subjects connected with mines.

PROFESSOR MILTON J. ROSENAU, of the Harvard Medical School, has been elected president of the American Society of Tropical Medicine.

AT the annual meeting of the American Surgical Association held in Rochester, Minn., last month, the following officers were elected: President, Dr. Robert G. Le Conte, Philadelphia; vice-presidents, Drs. Charles L. Gibson, New York City, and Archibald MacLaren, St. Paul; secretary, Dr. John H. Gibbon, Philadelphia; recorder, Dr. John F. Binnie, Kansas City, Mo.; and treasurer, Dr. Charles H. Peck, New York City. The 1916 meeting will be held in Washington.

DR. C. JUDSON HERRICK, professor of neurology in the University of Chicago, has been elected president of the honorary scientific society, Sigma Xi, at that institution. Director Edwin Brant Frost, of the Yerkes Observatory, has been elected vice-president.

MR. J. B. TYRRELL, of Toronto, was elected president of the Geological Section of the Royal Society of Canada at its recent annual meeting.

THE Alabama Polytechnic Institute has conferred the degree of doctor of science upon Altus Lacy Quaintance, in charge of deciduous fruit insect investigations in the U. S. Bureau of Entomology. Dr. Quaintance was at one time a student at this institution taking his master's degree there. This is the first doctorate of science conferred by the institution.

THE honorary degree of doctor of laws has been conferred by the University of Cambridge on Professor G. B. Mathews, F.R.S., formerly fellow of St. John's College, Cambridge, and on Dr. G. S. Middleton, president of the Association of Physicians of Great Britain and Ireland.

AT Cambridge University the Wiltshire prize in geology and mineralogy has been awarded to Mr. D. B. Briggs, of Jesus College. The Frank Smart prize in botany has been awarded to Mr. E. J. Maskell, Emmanuel College, and that in zoology to Mr. L. T. Hogben, of Trinity College.

PROFESSOR E. B. POULTON has been elected president of the Linnean Society.

Dr. George S. Graham has been appointed second assistant pathologist and Dr. Edgar M. Medler research assistant in pathology, at the Boston City Hospital.

Dr. Irving Perrine, professor of geology and paleontology at the University of Oklahoma, has resigned to become head geologist to the Pierce Oil Corporation, of St. Louis, Mo. With him goes Mr. L. E. Trout, at present chief geologist of the Oklahoma State Geological Survey. They will make their headquarters at Oklahoma City, Okla.

Curator William C. Mills, of the Ohio State Archeological Museum, will leave for Scioto County in two weeks, where he with two assistants, H. C. Shetrone, of the museum, and William Holdermann, of Columbia University, will superintend explorations in the mounds of that vicinity. This trip is taken by members of the Ohio State Historical and Archeological Society each year. The party which includes, besides a photographer, a surveyor and a working force, will live in tents during the summer. Data and relics will be collected and afterwards tabulated and recorded by Dr. Mills. Bound copies will be made of these records and placed in the museum.

Dr. Richard C. Cabot has been appointed medical adviser to Radcliffe College.

Sir Nathaniel Barnaby, the British naval engineer, died on June 15, at eighty-six years of age.

UNIVERSITY AND EDUCATIONAL NEWS

In honor of Dr. Wheeler, since 1899 president of the University of California, the regents have voted that the new classroom building to be begun in July, 1915, shall be named Benjamin Ide Wheeler Hall. This white granite building is being erected at a cost of $800,000 from proceeds of the bond issue of $1,800,000 voted in November, 1914. Plans are being prepared also for an additional agricultural building to cost $350,000; for the first unit of a new group of chemistry buildings, this structure to cost $250,000; and for the completion at a cost of $400,000 of the university library.

Arrangements for an exchange of professors between the University of Washington and the University of the Philippines have progressed to the stage where it is probable that Dr. Horace G. Byers, professor of chemistry in the University of Washington, will spend the next year in Manila. In the event of his going, Professor Horace G. Deming, a graduate of the University of Washington, head of the department of chemistry in the University of the Philippines, will go to the University of Washington for the year.

The trustees of Cornell University have elected Alexander M. Gray to be professor of electrical engineering and head of the department of electrical engineering in Sibley College. Professor Gray will begin his work at Cornell in the fall. He has been for several years a member of the faculty of McGill University. The head professorship of electrical engineering in Sibley College was resigned by Professor H. H. Norris two years ago and Professor Vladimir Karapetoff has been acting head of the department.

At the Carnegie Institute of Technology, James Burt Miner, of the University of Minnesota, has been appointed assistant professor of psychology. Louis L. Thurstone, graduate student at the University of Chicago, and Margaret L. Free, of Bryn Mawr, have been appointed assistants in the bureau of mental tests. Jonathan L. Zerbe and Katharine Murdoch remain as instructors in educational psychology. Among the aims of the department is the study of the psychology of industrial processes and of the teaching of those processes.

Dr. W. C. Allee, who had charge of the department of zoology at the University of Oklahoma this year, during the temporary absence of Dr. H. H. Lane, has been appointed head of the department of zoology of Lake Forrest College.

Dr. F. E. Chidester, assistant professor of biology and in charge of the courses in zoology at Rutgers College, has recently been promoted to the headship of a new department of zoology, with the rank of associate professor.

DR. GEO. I. ADAMS, who has been professor of geology and mining at the Pei Yang University at Tientsin, China, has been appointed to the faculty of the Government University at Peking.

MR. C. T. R. WILSON, F.R.S., lecturer in experimental physics at the University of Cambridge, has been elected to a fellowship in Sidney Sussex College for a period of five years.

THE board of Trinity College, Dublin, has appointed Miss E. M. Maxwell, of the Royal Victoria Eye and Ear Hospital, Dublin, to the Montgomery lectureship in ophthalmology.

DISCUSSION AND CORRESPONDENCE

APPLICATION OF PETROGRAPHIC METHODS TO ANALYTICAL CHEMISTRY

WHEN it is considered that minerals are fundamentally more or less definite chemical compounds and that optical mineralogy has attained a high stage of development and importance, it is a matter of considerable surprise that the application of petrographic methods to general chemistry has been attempted in so relatively few instances and that at present, speaking generally, crystal optics is a subject almost unheard of among the great majority of chemists. Chemical literature is filled with such vague crystal descriptions as "needles," "tablets," etc., which it is hardly necessary to say are almost worthless—absolutely so when taken out of connection with the reactions of the compounds. Crystallographic measurements are not always possible, are tedious, and lack general applicability. Microchemical reactions usually resolve themselves into simple observation of the appearances of the crystals formed, a procedure open to the objection that in many cases very diverse substances crystallize rather similarly. Petrographic methods are open to none of these objections. In a very large number of substances the optical data is definitive. The methods are of general applicability to crystalline material regardless of the existence or non-existence of crystal faces, and are rapid and comparatively simple.

It is well known that the rock-forming minerals are now usually determined by microscopic examination and that it is even possible to calculate approximately the chemical composition of a rock from the data thus obtained. In some rather rare instances these same methods have been extended to chemical compounds other than minerals. In 1898 J. L. C. Schroeder van der Kolk[1] published an acount of petrographic methods and applied them to certain artificial salts. Otto Rosenheim[2] by a determination of the optical characters, positive or negative, of phrenosin and kerasin, obtained from the brain, succeeded in differentiating these two substances. This test was confirmed in this laboratory on the same materials obtained from molds. Fry[3] has applied petrographic methods to the determination of the various salts ordinarily occurring in commercial fertilizers, and to the determination of mixed solids obtained in certain phase-rule work,[4] all cases where chemical analysis could not give the desired results. In a very recent address before the Chemical Society of Washington Dr. F. E. Wright called attention to the utility of petrographic methods in chemical analysis, and during this address and the succeeding discussion several specific applications were pointed out, notably that of the differentiation of the sugars. The published reports of Dr. Wright and coworkers afford numerous instances of the valuable application of petrographic methods to many substances, especially in the examination of products obtained in various melts. This work can not be too highly commended. Chamot[5] has emphasized the usefulness of the methods.

Recently the literature has been searched and practically complete optical data has been found for over 375 chemical individuals ranging from simple elements to the more complex inorganic and organic compounds. In addition there is an immense number of compounds of which some of the data is known. This makes it quite possible to definitely identify quite a

1 "Kurze Anleitung zur Mikroskopischen Krystallbestimmung," Wiesbaden.

2 *Biochem. Jour.*, 8, 110, 1914.

3 U. S. Dept. of Agric., Bul. 97, 1914.

4 Parker, *Jour. Phys. Chem.*, 18, 653–61, 1914.

5 "Elementary Chemical Microscopy."

number of chemical individuals and to differentiate a vastly larger number. For simple differentiation, however, it should be understood that it is not necessary that any data be known since sufficient may usually be obtained in five minutes or less.

It is obvious that by the use of petrographic methods in chemical work an immense amount of time can be saved, a saving that overwhelmingly counterbalances the initial cost of equipment and the rather unimportant trouble of learning the methods. With numerous substances the necessity for tedious qualitative analysis can be obviated or at least greatly limited. Reagents or precipitates, where extremely accurate results are not sought, may be examined for purity with scarcely more than a glance. This is of great value in various phases of drug examination or general inspection work. In this laboratory the petrographic microscope has supplanted a large amount of routine chemical analysis with a consequent saving of both time and reagents.

This paper is written with the purpose of calling to the attention of chemists the fact that, while the petrographic microscope can never entirely supplant chemical analysis, it may be and actually is an aid which can not fail to be of very great service both to the research and to the commercial worker.

William H. Fry

Bureau of Soils,
U. S. Department of Agriculture,
Washington, D. C.

TO THE AMERICAN PHYSICAL SOCIETY

In his announcement of June 25th to the members of the American Physical Society, Professor Cole expresses the fear that there will not be room on the program of the San Francisco meeting of August 6 for many papers from eastern members. Evidently Professor Cole has overestimated the numbers or the scientific activity of the members of the Physical Society on the Pacific Coast.

It is the belief of the coast committee on program that there will be ample time for the reading of all papers that our eastern members are willing to present, and accordingly this committee especially invites papers from the eastern members at this session.

Fernando Sanford,
E. P. Lewis,
For the Committee

A CORRECTION

May I be allowed to call attention to a printer's error in my article entitled "Some Reasons for Saving the Genus," which was published in Science for June 18, 1915? The concluding sentence (p. 902) was rendered entirely ineffective by the omission of a line. The sentence should read: "In this conflict the 'general biologist' should, I think, lend his support to that faction which shows the higher regard for the interests of the scientific public."

F. B. Sumner

A CHICKEN WITH FOUR LEGS

On December 15, 1914, a chicken was hatched out of one of our settings which had four legs. It lived from one evening to the next noon when it was stepped upon by the mother-hen and killed. It seemed to be normal in every other respect, eating and walking about like the others, of the usual markings and full size but not unusually large.

The two extra legs were at either side of the extreme rear of the body, appeared to be complete in all the essentials, having the three main toes and the small toe together with toenails. These extra legs were about two thirds the size of the principal ones, were a lighter yellow in color and had the toes facing the rear, the opposite to the ordinary ones.

In walking, the chicken curled up the extra legs behind it, using only the principal ones.

It was of the Plymouth Rock breed and nothing unusual was noticeable about any of the eggs of the setting. There did not seem to be anything unusual in the fertility of the eggs—hatchings running from two to eleven chickens. Six eggs of the setting in question hatched and all the remainder appear entirely normal.

This specimen was sent to the Museum of the Escuela de Agricultra here.

C. D. Perrine

Córdoba, December 22, 1914

SCIENTIFIC BOOKS

Vorlesungen über allgemeine Histologie gehalten an der Hochschule für Frauen in St. Petersburg. VON ALEXANDER GURWITSCH. Jena, Gustav Fischer, 1913. Pp. vi + 345. 204 figs.

Professor Gurwitsch has taken seriously his task of instructing the college women of Petrograd. He has prepared for them a course so philosophical that if adopted for American young men, the audience would be restive, if not more disrespectful. But he appreciates that he is not dispensing milk for babes, and quotes Helmholtz that the academic teacher should always be mindful of this—that among his hearers there are perhaps "die besten Köpfe" of the next generation, and they are to be reckoned with. Accordingly he presupposes an "elementary zoological, anatomical and botanical knowledge" on the part of his students, and correctly infers that his work "perhaps makes greater demands upon the attention of the reader than many another compendium of histology." For this the reader is amply rewarded.

The first of the twenty-two lectures deals with "the position of histology in the system of the biological sciences." In this abstract consideration, histology is shown to be far removed from a naïve, automatically-recording science, limited only by optical and technical difficulties. Its real difficulties are those of subjective interpretation, and the author ranks it high among the various attempts to secure a better understanding of vital phenomena. But he emphasizes the fact that the study of structure is only one method of approach among many which are available, and "we do not know how far toward the goal it can lead us."

Each subject discussed in the lectures is introduced with the formulation of a biological problem. Thus the second lecture—on "the fundamental conceptions of microscopic morphology"—begins with the statement that the first and most urgent problem is the endless *multiplicity of forms* which organisms present. Can all organisms be regarded as various arrangements of one or a few sorts of structural elements? It is then shown that the Protista, from the simplest amebæ and bacteria to the highly organized infusoria, appear irreducible. They show an essential agreement only in the "heterogeneity of their architecture." But such forms as the hydroid polyps, the vegetative buds of *Equisetum* and embryos of the higher animals, are composed of elements, or cells, which show many more interrelationships and analogies among themselves than are presented by the organisms *in toto*. To this extent the cell theory is justified and significant. In the adults of the higher animals, however, the consideration of striated muscle fibers and of various supporting tissues leads the author to state that the cell theory is here "simply inadequate," and he finds that "the ground substance, the cell, the fiber (ducts in plants), etc., must be accepted as coordinate descriptive material in our histological inventory." But he regards granules as having no more general characters than their configuration, and every granule theory is declared illusory.

The third lecture is entitled the "substratum of development," and approaches the problem of the origin of new organisms. After noting that the earliest beginning of the future organism which can be recognized and individualized as such, has its own antecedent in the maternal organism, not recognizable with the methods of to-day but which may be with those of to-morrow, Dr. Gurwitsch proceeds to consider the ovum, and thus the nature of protoplasm in general. In abbreviated form, he writes:

> The investigation of protoplasmic structure is among the pet problems of histology. If only seldom expressed, most of such studies have been inspired by the wish and hope of finding something in the structure of protoplasm which would explain its "properties." But this hope gradually paled as the investigator became lost in the labyrinth of microscopic pictures. There was a lack of sufficient appreciation of the part which induction plays in apparently so simple a procedure as describing what is seen. Many times we imagine that we accomplish this in a purely objective way, when in

fact we offer an interpretation. Since the pictures admit of different interpretations they must be examined in the light of the physical properties of protoplasm. To have perceived and applied this postulate is the unperishable contribution of Bütschli.

Accordingly nucleus and protoplasm are thoroughly examined in their physical and chemical relations, and the manifold structural forms assumed under the microscope are partially explained by considering protoplasm a very soft gel, near the critical condition. "Under various abnormal or perhaps physiological conditions it may wholly or in part become a sol."

Two lectures are devoted to cell division, and like all other parts of the book, they are illustrated with large, clear, beautifully executed figures, derived from many sources. Collectively they suggest faultless technique and the clearest of objectives. The account of mitosis imparts the fascination which this process still holds upon the lecturer through its inherent mystery, and the subject is left with the following characteristic conclusion:

> Why the number of chromosomes and their size are so very different in closely related species or races; why specially in the seminal cells of one representative of the cyclostomes (*Myxine*) peculiarly formed rod-shaped centrosomes appear; why the centrosomes of a particular annelid (*Rhynchelmis*) attain enormous, macroscopically visible dimensions, etc.; these all are problems the rational explanation of which can not be hoped for in the years within sight.

The course continues with a consideration of the following themes: Growth; the substratum of inheritance; shape and structure; the histology of metabolism; change of form and motion; the nervous system; and finally, the possibility of establishing histological laws. Each of these subjects is treated in one or more lectures, with freshness and originality. The two lectures on "shape and structure" state that the adult is characterized by relatively stabile weight and fixed shape, and this condition is attributed to "the high degree of elasticity in the adult organism as contrasted with the plasticity of embryonic stages." The structures accounting for these characteristics of the adult are then considered—epithelium and its modifications in the first lecture, with the conclusion that "in maintaining the typical shape of the organism, epithelial tissue as such plays a subordinate rôle"; and connective tissue, with cartilage and bone, in the second lecture.

As a whole the lectures are to be highly commended. Their unsolved riddles may perhaps suggest to others, as to the reviewer, the difficulties of Carlyle's Teufelsdröckh, but much is in store for the English readers who "accompany him through all his speculations." Of inconsistencies we have noted only one, and can not decide which of the following propositions is correct:

> Histological investigation is seldom or only exceptionally able to take the lead over other methods of investigation as a pioneer in unknown lands (p. 11).

> Histology belongs essentially to the sciences of discovery, so that histological discoveries have often, or very generally, the same exploratory character as the voyages of the early mariners (p. 4).

Frederic T. Lewis

Flies in Relation to Disease—Bloodsucking Flies. By Edward Hindle, B.A., Ph.D. Cambridge University Press, 1914.

This volume is one of the Cambridge Public Health series and complements the recent work on flies in relation to disease by Dr. G. S. Graham-Smith. It was written in collaboration with the distinguished investigator, Major S. R. Christophers, who, for reasons stated in the preface, did not consent to appear as joint author. In its preparation the author was also guided by Professor G. F. H. Nuttall. It is therefore to be supposed that it measures up to the standard set by the noted Quick Professor of Protozoology in Cambridge University. The reader will find as he proceeds through the work that this is the case.

Dr. Hindle's volume deals with the most important field in medical entomology at the present time as its scope includes the treatment of species transmitting such important maladies as malaria, yellow fever, sleeping sickness and others. In this field much activity

has been displayed in recent years. Most of the European nations which have possessions in Africa have sent scientific expeditions to that continent to study the insect-borne diseases. In the case of England, the Royal Society, the Imperial Bureau of Entomology, and the great schools of tropical medicine have sent such expeditions. As there has been an urgent demand from administrative officers and others for early information on the subject of African insect-borne diseases, many of the commissions and investigators have published preliminary or progress reports from time to time. The undertaking of the author of this book was to summarize and correlate as far as possible the findings of the different investigators which in many cases have not been harmonious. Dr. Hindle himself has conducted investigations in various parts of Africa and adds his own views to those of other investigators on points which are by no means settled.

The general plan of the work is to combine the necessary entomological and medical features of the problem so that the accounts of the different diseases will be complete. In the treatment of diseases borne by mosquitoes, for instance, a full discussion of the classification of the mosquitoes is given. This is followed by a series of chapters on the diseases such as malaria and yellow fever which these insects transmit. The completeness of the work may be judged from the table of the two hundred and forty-one species of anopheles, their classification and generic synonymy, and notes on their habitat and connection with malaria. Even with such complete special discussions the work is well balanced, but its chief characteristic is its inclusiveness and the good judgment the author has displayed in the exclusion of immaterial details.

Dr. Hindle lost his life in military operations in Africa, where he was continuing his investigations of tropical diseases, soon after the outbreak of the war. He was a young man and would undoubtedly have made further valuable contributions to the study of insect-borne diseases. But the present book may be considered a monument that will mark his place, which was an important one in the study of tropical diseases at a time when such work as his was much needed. W. D. HUNTER

SPECIAL ARTICLES

THE DIFFUSION OF GASES AT LOW PRESSURES MADE VISIBLE BY COLOR EFFECTS

AN interesting and instructive experiment for the lecture table is to connect a discharge tube AC, which is about one meter or more in length and which has the exhaust nipple at one end, to a pump that will give a Geissler vacuum—an oil Geryk pump will answer very well. Between the pump connection M and the valve O that closes the tube there should be fused a side branch N also having a valve. Connect N by a rubber tube to some source of gas other than air, *e. g.*, ordinary illuminating gas. The connection at M should be made direct to the pump. Connect A and C to the terminals of an induction coil that will give a spark in air five or more centimeters long.

To operate, close the valve in the branch N, open O and evacuate the discharge tube to the point where on sparking the characteristic striæ show distinctly. It is immaterial whether A or C is the cathode, or whether the discharge is unidirectional. Now close the valve O, and, with the pump still running, open N partly, allowing illuminating gas to be drawn by the pump through the branch OM, thus displacing the air by the gas. By closing N, pumping and later admitting more gas, every trace of air may be washed out of

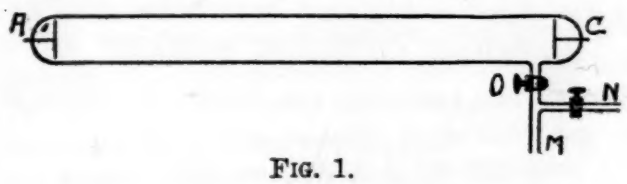


FIG. 1.

the tube leading up to O. Now with N closed allow the pump to run for a few seconds until it is judged that the pressure in the connecting tube MO is about that in the discharge tube AC.

At this stage everything is in readiness for the experiment, namely, the diffusion of gases at low pressures made visible by the color effect. The well-known characteristic color of the discharge in the case of residual air, con-

taining possibly some water vapor, is orange red. To now introduce the illuminating gas open the valve *O* for a moment, then close it. The end *C* of the discharge tube is instantly filled with a beautiful greenish-white color characteristic of illuminating gas. This color will diffuse slowly towards *A*, each color paling out, and after three or four minutes the discharge throughout the tube will assume a uniform grayish hue. The rate of diffusion is surprisingly slow and of course depends upon a number of factors, *e. g.*, the gas pressure in the tube, the pressure of the gas that is admitted, the ionization within the tube due to the discharge passing through the tube, the amount of moisture present, etc.

If now the gas connection at *N* be removed and this stem opened to the air the pump and connections may be freed of gas and the inverse experiment performed; namely, that of introducing a small quantity of air. The resulting orange red color and its diffusion through the grayish hue of the illuminating gas is even more striking than the first.

The success of the experiment depends largely upon the skill of the operator in properly proportioning the quantity of gas to be introduced. It is a very simple experiment to perform.

Chas. T. Knipp

Laboratory of Physics,
University of Illinois,
June 2, 1915

THE NEW ORLEANS MEETING OF THE AMERICAN CHEMICAL SOCIETY. III

Division of Physical and Inorganic Chemistry

G. A. Hulett, *chairman*
R. C. Wells, *secretary*

E. R. Weaver: *A Colorimetric Determination of Acetylene.*

A new colorimetric method for the determination of very small amounts of acetylene in gas mixtures depends upon the formation of a red colloidal solution of cuprous chloride containing gelatine and alcohol. Comparison is made with a solution of a red dye or a piece of ruby glass. In the gravimetric determination of acetylene it has been found necessary to exclude air during the filtration and washing of the precipitate.

George W. Morey: *The Ternary System K_2O-SiO_2-H_2O from 300°–700°.* (Lantern.)

E. C. Franklin: *Rubidium Ammonosodate and Ammonopotassiate.*

R. S. McBride: *Experiments on the Distillation of Liquid Air in a Magnetic Field.*

Preliminary experiments on distillation of liquid air in a strong magnetic field indicate that there is an improvement in the separation of oxygen and nitrogen due to the influence of the magnetic field.

E. P. Schoch and Denton J. Brown: *A Systematic, Rapid, Electroanalytical Procedure for the Separation and Determination of Silver, Arsenic, Copper, Bismuth, Antimony, Tin, Lead and Cadmium.*

In our earlier work, published elsewhere, we have shown that copper, tin, lead, bismuth and antimony can be determined accurately by electrodeposition out of acidified chloride electrolytes which contain suitable reducing agents such as hydroxylamine or formalin. We have found since that copper, bismuth and antimony can be deposited simultaneously, and can be separated from tin and lead; that tin and lead can be deposited simultaneously and separated from cadmium; that copper or bismuth can be separated from antimony by dissolving alloys of these metals in nitric acid plus tartaric acid and electrolyzing the solutions with a limited cathode potential; that bismuth phosphate can be precipitated quantitatively out of the same solution; that tin may be separated completely from lead by dissolving an alloy of these two metals in nitric acid plus potassium nitrate; and that silver in silver chloride may be determined by dissolving the latter in ammonia, adding ammonium nitrate and electrolyzing.

These facts are all combined in the following systematic procedure for the rapid electroanalytical determination of all the common metals the potentials of which are more noble than that of cadmium.

(*A*) Dissolve sample in hydrochloric acid or in aqua regia; an insoluble residue—silver chloride—is dissolved in ammonia plus ammonium nitrate, and the silver determined electrolytically.

(*B*) Treat solution *A* with hydroxylamine—mercury, gold and platinum will be precipitated and can be determined by well-known methods.

(*C*) Out of filtrate *B*, remove arsenic by distillation with hydrochloric acid, and determine arsenic iodometrically.

(*D*) Electrolyze *retort residue C*—copper, antimony and bismuth will be deposited with a cathode potential limited to 0.45 volts (against the normal calomel electrode).

(*E*) Dissolve *metal deposit D* in nitric acid plus tartaric acid, and precipitate bismuth as bismuth phosphate.

(F) Electrolyze *filtrate E* with a limited cathode potential—copper alone will be deposited. Antimony is obtained *by difference.*

(*G*) Electrolyze *residue D* with a cathode potential limited to 0.7 volt against the normal calomel electrode: tin and lead will be deposited. Treat the deposit with nitric acid plus potassium nitrate: the solution contains all the lead, and this metal may be deposited as lead peroxide, or the residue of tin oxide may be dissolved in hydrochloric acid plus hydroxylamine and the tin determined by electrolysis.

(*H*) Electrolyze *residue G* to obtain cadmium or other metals.

P. SCHOCH and W. A. FELSING: *The Influence of the Potassium Ion upon the Potential of the Ferrocyanide-ferricyanide Electrode.*

The potential of the ferrocyanide-ferricyanide electrode is made more noble by the addition of potassium salts to the electrolyte, but the amount of this change in potential is much greater than the amount calculated from the change in the ratio of ferrocyanide to ferricyanide ions when the concentrations of the latter are calculated from the conductivity ratio and with the aid of the rule of mixtures as set forth by Sherrill. It was suggested by Lewis that this extra effect may be due to the potassium ion taking part in the pole reaction. Thus, with the undissociated salts, the reaction would be: $K_3Fe(CN)_6$ plus K-ion plus one electron gives $K_4Fe(CN)_6$—and it has been shown recently by Mueller that with concentrations of potassium ion ranging from 0.2 normal to 0.8 normal the amount of change in potential corresponds to the amount of change in the potassium ion if the concentration relations of the other substances remains constant. Since the latter is not likely to be true, and since the potassium ion shows the same influence even in the most dilute solutions tried, the authors sought to ascertain whether or no the concentration influence of the potassium ion is constant with a particular power of its concentration. This was found to be the case with the .75 power of the potassium ion concentration, and if the ferrocyanide and the ferricyanide ion concentrations are calculated from the conductivity ratio and the rule of mixtures. The various mixtures tried present a range of total potassium ion concentration from 7.8 millimol to 395 millimol per liter. In some mixtures the potassium ion was derived wholly from the iron cyanides, in others, almost wholly from potassium chloride, and in others still, partly from both sources. The different potentials thus reduced to unit concentrations present a maximum range of 8 millivolts with this large variation of concentrations, and hence the result may be considered to be constant. Furthermore, it is likely that on repetition measurements will be obtained which will show considerably less variation.

Since the calculations of the above potentials involve the general dilution law of strong electrolytes and the rule of mixtures, it was desirable to test these calculations in some way, hence the conductivities of these mixtures were measured and compared with their calculated values. When allowance is made for the influence of the viscosities of the solutions, then the observed and the calculated conductivities agree to one per cent. and less.

The work is now being repeated with calcium salts in place of potassium salts. Although the immediate result of this work is the establishing of an empiric relation between concentrations and pole potentials, yet it is likely that the results will throw some light on the manner of ionization of salts with polyvalent ions—particularly because other electrodes such as the thallous-thallic, the ferrous-ferric and the mercurous-mercuric, show similar relations.

R. G. VAN NAME and D. U. HILL: *The Rates of Solution of Metals in Ferric Salts and in Chromic Acid.*

The observed rates of solution were lowered by increasing the concentration of free sulphuric acid. In ferric sulphate with 0.5-molar acid the rates differed and were higher the more electropositive the metal. With 10-molar acid the four most electropositive metals tested all gave the same rate. The lowering of the rate with increasing acidity is due to increase in the viscosity, which retards the diffusion. In general all results are in agreement with the diffusion theory of heterogeneous reactions, but the marked dependence upon the nature of the metal, observed at the lower acidity, contradicts Nernst's hypothesis that, where no secondary effects interfere, the rate of the chemical reaction proper (as distinguished from the diffusion proeess) must always be extremely high.

Paul M. Giesy and James R. Withrow: *The Electrolytic Preparation of Solid Alkali Amalgams in Quantity.*

Kerp, by his method, obtained 200 gr. of solid potassium amalgam in 4 to 5 hrs. This method has been modified so as to yield 490 gr. in ½ hr. As previously found, Shepherd's method did not give pure amalgams. Smith and Bennett, by their method, using 3 amp. current, obtained about 180 gr. solid sodium amalgam. By using 20 amp. current, and cooling the cell by an ice-water bath, 680 gr. were obtained in 2¼ hrs. It is not necessary to cool the cell in the case of potassium amalgam. After electrolyzing 50 min. with 1,000 gr. mercury and 20 amp. current, 1,015 gr. of solid potassium amalgam were obtained by chilling.

O. L. Barnebey: *Permanganate Determination of Iron in the Presence of Fluorides. The Analysis of Silicates and Carbonates for their Ferrous Iron Content.*

In a systematic study of the effect of various reagents toward increasing the accuracy of titrating ferrous iron in the presence of fluorides, boric acid was found to give the best results. Boric acid when added to the ferrous solution preceding titration converts the hydrofluoric acid to metafluoboric acid, HBF_4, which does not interfere with the permanganate reaction. This use of boric acid is applied in the analysis of silicate and carbonate rocks for their ferrous iron content.

O. L. Barnebey: *The Permanganate and Iodimetric Titration of Iodide in the Presence of Bromide and Chloride.*

The Pean de St. Gilles permanganate method of titrating iodide to iodate has been modified by adding manganous sulfate with the ferrous sulfate in removing the excess of permanganate. This prevents the liberation of bromine or chlorine at this stage of the analysis as well as later when titrating the excess of ferrous sulfate with the permanganate. After the completion of the permanganate titration the iodate formed may be determined by adding phosphoric acid and potassium iodide and titrating the liberated iodine with thiosulfate.

Hal Walters Moseley: *The Phenomenon of Passivity in Connection with Ferrous Alloys of Different Composition and Structure.*

The author has shown that samples of iron and steel of very different composition and structure can be made passive with a definite current density when the samples were made the anode in an electrolytic cell. The nature and concentration of the electrolyte are also factors influencing the establishment of the passive state. The current density required is not related in any simple way to the composition or structure of the samples.

The results confirm the view that the phenomenon is perfectly general for all classes of irons and steels, and show that passivifying agents as inhibitors of corrosion have a very wide applicability.

William C. Moore: *The Thermo-electric Properties of Carbon.*

Preliminary experiments with various combinations of arc carbons as thermo couples showed that each particular combination had individual thermoelectric characteristics.

More elaborate measurements were then made with various carbon copper couples. The burning of such couples at high temperatures was so serious that the simple carbon copper couple was modified by enclosing the arc carbon rod within a copper tube, the combination serving as a couple, the tube being partially exhausted by a water pump.

With several of the carbon-carbon couples and some of the carbon-copper couples, a point or a region of maximum electromotive force was found. With one carbon-copper couple this region exceeded from 741° C. to 816° C.; with another carbon-copper couple, this region exceeded from 514° C. to 565° C. These carbons were of different composition and had different manufacturing histories. The temperature coefficient of the electromotive force of these couples was very irregular before reaching the region of maximum electromotive force; after passing through this region this coefficient became more regular, and the slope of the $de/dT - T$ curve changed. The carbon was negative at the cold end, but in one case became positive at a high temperature. The carbon used in a different carbon copper couple was positive throughout the experiment, an E.M.F. of 2.18 millivolts being reached when the furnace temperature was 878° C. In this case the electromotive force did not pass through a maximum.

The electromotive force of the one carbon-carbon couple reached a value of 14.59 millivolts at a furnace temperature of 707° and a cold junction temperature of 55.5°.

In general, this is higher than that reached by

carbon copper couples. The variations shown by any one couple in general are reproducible. The results show that the thermo-electric properties of carbon depend on the initial composition and the manufacturing history of the carbon.

It is possible that the change in direction of the temperature coefficient-temperature curve indicates that some of the carbon material undergoes a transition into some other material. The results here reported seem to show that ordinary carbon is a mixture of several substances—in all probability several varieties of carbon with various hydrocarbon bodies of high molecular weight, since Moissan[2] has shown that all forms of amorphous carbon contain hydrogen.

D. A. MACINNES and KARR PARKER: *Potassium Chloride Concentration Cells.*

J. P. MONTGOMERY: *The Precipitation of Lead Chloride in Qualitative Analysis.*

STEWART J. LLOYD: *Radium Content of Water from the Gulf of Mexico.*

Previous Results.—One liter of sea water contains in grams of radium:

Jolly	17.0×10^{-12}
Eve	0.3×10^{-12}
Eve	0.9×10^{-12}
Satterly	1.0×10^{-12}

Seven and one fourth liters of Gulf water evaporated down and measured gave 1.7×10^{-12}. The amount of radium in the ocean is hence probably about 1,400 tons, which implies a content of uranium of 4,200,000,000 tons.

W. A. TAYLOR: *Studies in the Measurement of the Electrical Conductivity of Solutions.*

WILLIAM J. VAN SICKLEN: *Electrolytic Rectification of Alternating Currents.*

A number of cells were devised varying within wide limits several factors affecting the energy efficiency of rectification. The electrodes used were for the most part iron-aluminium, carbon-aluminium, nickel-aluminium. The affect of the following factors on the energy efficiency of rectification were determined: relative area of and distance between electrodes, E.M.F. of the input circuit, resistance in the output circuit, nature and conductivity and temperature of the electrolyte. The alternating current used throughout the determinations was of 60 cycle frequency.

[2] "Electric Furnace," p. 48, 1904 ed.—Lenher's translations.

WILLIAM D. HARKINS and ERNEST D. WILSON: *The Changes of Mass and Weight Involved in the Formation of Complex Atoms.*

WILLIAM D. HARKINS and ERNEST D. WILSON: *The Structure of Complex Atoms.*

WILLIAM D. HARKINS and ERNEST D. WILSON: *Nuclear and Valence Electrons.*

WILLIAM D. HARKINS and ERNEST D. WILSON: *A Periodic Table which Plots the Atomic Weights of the Ordinary and the Isotopic Elements.*

ERNEST D. WILSON and WILLIAM D. HARKINS: *A Connection between Planck's Quantum Hypothesis, the Magneton, and the Balmer Series Formula.*

LLOYD C. DANIELS: *Cuprous Salts of Oxygen Acids and a New Method for Preparing Cuprous Salts.*

References are given to the salts of this class that have been described. They are the sulfite, sulfate, ammoniated sulfate, carbon monoxide compound of the sulfate, acid thiosulfate and acetate.

The brown insoluble product of the action of oxalic acid on cuprous sulfite is shown by its clear colorless solution in hydrochloric acid, by its clear solution in ammonia, and by its formation of calcium nitrate and nitric acid, to be a new salt of this class. Analysis shows its composition to be $Cu_2H_2(C_2O_4)_2$. The same method is to be applied to the preparation of other cuprous compounds.

M. A. ROSANOFF: *A Relational Process of Fractional Distillation.*

WATER, SEWAGE AND SANITATION SECTION

Earle B. Phelps, *chairman*
H. P. Corson, *secretary*

The following list of officers of the Division of Water, Sewage and Sanitation, were elected for 1915:

Chairman: Edward Bartow.
Vice-chairman: Earle B. Phelps.
Secretary: H. P. Corson.
Executive Committee: Edward Bartow, Earle B. Phelps, H. P. Corson, C. P. Hoover, E. H. S. Bailey.

F. W. Bruckmiller: *The Use of Benzidene for Sulfates in Water Analysis.*

Edward Bartow and A. N. Bennett: *The Determination of Arsenic in Filter Alum.*

European specifications require that filter alum be free from arsenic. This suggested an investigation of filter alum used in the United States. Samples collected from plants in Illinois showed not more than 4 parts per million of As_2O_3. Since the Illinois plants are supplied from western manufactories, samples were obtained from plants throughout the east. Larger amounts of arsenic were found in some of the specimens obtained. Only traces of arsenic were found in water treated with alum, containing the highest amount of arsenic found. While this would indicate a strong possibility that the presence of arsenic in filter alum is not significant, the authors would recommend that preference be given to alums with a low arsenic content.

C. P. Hoover: *The Manufacture of Alum at the Columbus Water Softening and Purification Works.*

The process most generally employed to-day for coagulating and purifying water contemplates applying to the water under treatment a solution of aluminum sulfate. The cost of this chemical varies from $17 to $20 per ton.

A plant for making alum has recently been built and put in service at the Columbus Water Purification Plant. This is the first plant of its kind ever built at a water purification works for making alum to coagulate water, and, although it has only been in operation a short time, it has been a success both technically and economically. The process is short, simple and inexpensive, because it consists simply in boiling bauxite with sulfuric acid and applying the resultant solution to the water under treatment, thus eliminating five distinct steps in alum-making, namely: filtering, concentrating, crystallizing, grinding and redissolving. An investment of $12,000 was required for its construction, and it has been conservatively estimated that $6,000 per year will be saved the city in the cost of alum. Between 800 and 1,000 tons of alum will be manufactured during the coming year at a cost of about $10.50 per ton.

Arthur Lederer: *Determination of the Biochemical Oxygen Demand by the Saltpeter Method in Stockyards, Tanneries and Corn Products Waste.*

The saltpeter method was originally described by Lederer in the *Journal of Infectious Diseases*, 14: 482 (1914). In short, the method depends upon the denitrification of a sodium nitrate solution when incubated for a definite period (10 days at 20° C., or 5 days at 37° C.) with sewage or polluted water. The residual nitrite-nitrate oxygen is determined analytically. The method permits a comparison of the strength of sewages from the deoxygenation standpoint. The oxygen demand of domestic sewages usually varies between 100 and 300 p. p. m. of oxygen. The method can be applied to slaughteringhouse wastes without modification. The oxygen consumption of the Chicago stockyards waste in the Center Av. sewer fluctuates around 1,000 p.p.m., 20 per cent. of which is consumed during the first twenty-four hours. The oxygen demand of combined corn products waste fluctuated between 400 and 1,200 p.p.m., approximately 7 per cent. of which was used up in the first twenty-four hours. In this and in tannery waste the presence of lime or acid should be guarded against. If free lime is present it must be neutralized with dilute hydrochloric acid previous to incubation with sodium nitrate. If acid is present neutralize with sodium bicarbonate. The oxygen demand of a calfskin tannery waste investigated fluctuated between 400 and 1,000 p.p.m., 7 per cent. of which was used up in the first twenty-four hours. If a waste is sterile or devoid of sewage bacteria "seed" it with a few c.c. of sewage or polluted water. The general principles brought out in the work with the wastes mentioned can be applied to other wastes.

Earle B. Phelps: *Ventilation Studies.*

Edward Bartow and F. W. Mohlman: *Purification of Sewage by Aeration in the Presence of Activated Sludge.*

Domestic sewage from the city of Champaign has been treated according to the method suggested by Ardern and Lockett.[3] When raw sewage is aerated without the addition of sludge ammonium nitrogen is replaced by nitrite nitrogen, the nitrite nitrogen in turn being replaced by nitrate nitrogen. In the presence of sludge, the nitrite nitrogen is never present in large quantities. Ammonium nitrogen is apparently changed directly to nitrate nitrogen. The time of nitrification is reduced from fifteen days to four hours. The predominant organism in the sludge is an annelid worm, known as *Aeolosoma hemprichi*, although other microscopic animals are present. The sludge

[3] *Jour. Soc. Chem. Ind.*, 33: 523–39; 1,122–24.

does not have an unpleasant odor, although it will putrefy if kept for a long time in a moist condition without air. The dried material contains 6 per cent. of nitrogen; 1.44 per cent. of phosphorus. These figures would indicate its value as a fertilizer, which fact has been confirmed by pot cultures. Portions of the dried sludge showed excellent growths of wheat at the end of 18 days. The experiments are being continued on a larger scale.

RAY C. WERNER: *Sanitary and Mineral Properties of the Water Supplies of Georgia.*

A sanitary water laboratory was established by the Georgia State Board of Health in May, 1910, and a sanitary survey of public water supplies undertaken. The work has been limited, due to lack of funds, but about thirty water works plants have been inspected and analyses have been made from most public supplies of the state. The interest of superintendents and other officials of water works is growing and some water works laboratories are being installed in the state. Mismanagement and lack of understanding of technical features of purification leads to poor filtering results in some cities.

Supplies of the state are in general: Filtered stream waters in northern half and deep wells in southern section. The stream waters are usually turbid and more or less colored, but are not grossly contaminated. These waters are soft. The deep well waters are excellent in appearance and sanitary quality, and are fairly high in mineral contents, but few if any are treated for softening before use.

W. L. STEVENSON and others: *Analytical Methods for Sewage Works Operation.*

JOHN L. PORTER: *The New Orleans Water Purification Works.*

H. P. LETTON: *Rat Proofing of Wharves as an Anti-plague Measure.*

H. E. HALE and T. W. MELIA: *A Comparison of Methods for Determining Putrescibility or Oxygen Demand.*

E. J. TULLY: *A Sanitary Survey of Lake Michigan together with a Study of Stream Pollution along the Wisconsin Shore.*

It is established as a result of this investigation that the water of Lake Michigan along the Wisconsin shore is not a uniformly safe source of supply. The water is polluted and at times quite heavily so, not only in the immediate vicinity of sewer outfalls, but throughout the entire literal area studied, even to a distance of seven miles from shore, and municipal supplies are frequently more or less polluted.

It is therefore recommended that all public water supplies be purified and it is advised that sewage be subjected to adequate treatment before disposed by dilution.

DIVISION OF ORGANIC CHEMISTRY

F. B. Allan, *chairman*

C. G. Derick, *vice-chairman and secretary*

The division of organic chemistry held its meetings in Parlor "E" of the Grunewald Hotel, Friday, April 2, 1915, with Vice-chairman C. G. Derick presiding. Of the thirty-two papers listed, fifteen were given by the authors, eleven by abstracts and the remaining six by title only. Each paper was very freely discussed although the average attendance at morning and afternoon meetings was only fifteen.

EDWARD KREMERS: *The Classification and Nomenclature of Organic Compounds.*

VICTOR P. LEE: *Dimethylsulfate as a Methylating Agent.*

Many methyl ethers have been prepared with the object of determining their value, if they possess any, either as perfume substances, or as diluents or softeners when mixed with other synthetic perfume substances. The use of dimethylsulfate for this purpose is not new but has not been used much until quite recently. As dimethylsulfate is now a comparatively cheap reagent, and as its use as an alkylating reagent is very simple, it is replacing methyl iodide to a great extent. A table of the compounds prepared is given and the method used is outlined.

FRANCIS D. DODGE: *Some Derivatives of Coumarin.*

The author has prepared addition compounds of coumarin with the acid sulphites of sodium and potassium. These are well crystallized salts, and are to be regarded as sulphonates of hydro-coumarin. On heating, they decompose smoothly into coumarin, alkaline sulphite and sulphurous anhydride. They combine quantitatively with one molecule of alkaline hydroxide, yielding sulphonates of ortho-hydro-coumaric acid.

The latter are very soluble salts, showing little tendency to crystallize, and by the action of strong alkaline hydroxides, at 100°, are converted into

salts of ortho-coumaric acid. These reactions afford a very convenient method for converting coumarin into coumaric acid.

By the action of acetic anhydride at the ordinary temperature, the sulphonate of hydro-coumaric acid reverts to the hydro-coumarin sulphonate, so that by this series of smooth reactions it is possible to pass at will from coumarin to coumaric acid, or *vice versa*.

An analogous compound of Limettin (dimethoxy-coumarin) with sodium bi-sulphite is described.

The author also calls attention to the characteristic behavior of the coumarins on hydrolysis, which may be of diagnostic value for compounds of unknown constitution.

L. F. Augspurger: *The Isolation of a Blue Hydrocarbon from Milfoil Oil.*

The blue color of certain volatile oils has long attracted attention, but thus far appears to have escaped rational chemical investigation. Thanks to the distillation of more than a liter of volatile oil of *Achillea millefolium* by Professor E. R. Miller last summer, the writer had several hundred cubic centimeters of the high boiling intensely blue fraction placed at his disposal. Thanks also to the observation made by Mr. A. E. Sherndal in the laboratory of Dodge and Olcott, that an artificial blue oil combines with phosphoric acid to form a labile addition product from which the blue hydrocarbon oil can be recovered by the addition of water, it became possible for the first time to isolate the blue substance of a natural oil in a pure state.

Analysis of the compound thus isolated revealed the composition $C_{16}H_{18}$. It will be seen at once that whereas this hydrocarbon has the same number of carbon atoms as have the sesquiterpenes, $C_{15}H_{24}$, its hydrocarbon content is much lower, hence it is less saturated. The most interesting observation of the investigation thus far is that the blue color is lost upon additions to the molecule. Apparently it makes no difference whether hydrogen is added (reduction with palladium hydrogen), phosphoric acid, or possibly other substances still to be tested.

Nellie Wakeman: *A Possible New Terpene from Monarda Punctata.*

Although Schumann in 1896 reported the presence of cymene, and Hendricks in 1899 that of limonene as results of the preliminary investigation of this oil, the subsequent study of larger amounts seemed to add to the complexity of the chemical study of the oldest of the *Monarda* oils.

A large amount of the non-phenol constituents of horsemint oil having been placed at the disposal of the writer, a more careful study was made of the hydrocarbon fractions than before. All endeavors to make the hydrocarbon which yields a nitroso chloride correspond with one of the known terpenes have failed. The melting point of its nitrol piperidine differs by 103 and 87 degrees respectively from that of limonene and dipentene and by 78 degrees from that of pinene. The benzylamine base shows no such striking differences. With aniline, however, it does not react as does limonene but resembles pinene.

As soon as new material that is now being prepared for further nitroso chloride experiments is ready, a third attempt to identify this hydrocarbon with known terpenes will be made. For a summary of the chemical studies of the *Monarda* see Bulletin 448 of the University of Wisconsin.

C. H. Herty and D. H. Killeffer: *The So-called Alpha and Beta Isomeric Resin Acids.*

Oliver Kamm and C. G. Derick: *The Structure of Certain Hydronaphthoic Acids.*

The evidence previously advanced for the structure of the isomeric dihydro-β-naphthoic acids was based upon the reactions of their dibromides. A study of the oxidation products from these unsaturated acids has verified the conclusions previously advanced.

C. G. Derick and Oliver Kamm: *The Correlation of Ionization and Structure in Unsaturated Acids.*

Conclusions are drawn chiefly from acids having the unsaturation in a ring structure, thus eliminating the possibilities of cis-trans isomerism. The effect of conjugation of double unions is shown and the method of determining the constitution of acids of unknown structure is indicated. The possibility of obtaining a quantitative expression for conjugation of Thiele's partial valences is expressed.

Oliver Kamm: *Some Tests for Qualitative Organic Analysis.*

Several tests used in the courses in qualitative organic analysis at the University of Illinois are mentioned.

1. The identification of the volatile fatty acids by means of a method based upon that advanced by Duclaux for quantitative work.

2. A test for aromatic amines based upon the fact that the oxalates of most primary aromatic amines are only sparingly soluble in water while those of secondary and tertiary amines are soluble. Many of these oxalates may be titrated quantitatively, thus assisting in the identification of the amines.

3. A rapid test for the nitro group by reduction with sodium amalgam is discussed.

W. F. MONCREIF, JR., and J. T. MCGILL: *Qualitative Organic Analysis.*

An account is given of the development of systematic qualitative organic analysis; the methods used by some of the workers in this subject are compared; and the status of the subject in the curricula of a number of American colleges and universities is discussed. Emphasis is laid upon its advantages as a supplement to the usual organic preparation work.

E. C. WHITE and S. F. ACREE: *Recent Progress in the Study of the Quinone Phenolate Theory of Indicators.*

By the use of phenosulphonaphthalein it has been possible to show that a solution of the monobasic salt of the structure

(I) $(NaO_3SC_6H_4)C(:C_6H_4:O)\ (C_6H_4OH)$

is not deeply colored as compared with that of the diabasic salt

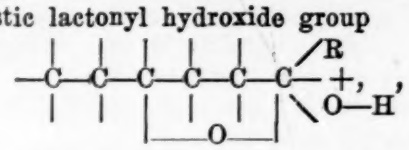
(II) $(NaO_3SC_6H_4)C(:C_6H_4:O)\ (C_6H_4ONa)$.

The monobasic salt has precisely the same color as the free acid, as is shown by titrating the acid with alkali (experiment performed at the meeting) as well as by a study of the adsorption spectra of solutions of the acid, the monobasic salt, and the dibasic salt (spectrophotographs shown at the meeting). The acid and the monobasic sulphonate are orange colored in solution, whereas the dibasic salt is purple. The former two substances already have a quinone group, but as the intense color does not appear until the dibasic salt is formed, it is clearly demonstrated that not the quinone alone, but the combination of quinone and phenolate groupings is the cause of the intense color.

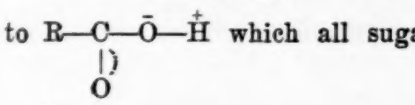
The effects of substituent groups on the acidity of the phenol and sulphonic acids, and the relations of these effects to color in the acids themselves and their salts are being studied. The results secured up to this time with the tetrabrom and tetranitro derivatives indicate that the significant color changes are associated with the formation of the complex *quinone phenolate anion* $RC(:C_6H_4:O)(C_6H_4O)$.

S. F. ACREE: *A Theory of the Unsaturation of Sugars and their Derivatives by Acids and Alkalies.*

In the mutarotation of sugars and their derivatives, the catalytic activity of the hydroxyl ion depends upon the formation of an anion of the characteristic lactonyl hydroxide group



analogous to



which all sugars possess if they show mutarotation by alkalies. When this lactonyl hydroxyl is used up in glucoside formation such anions can not form and no mutarotation by alkalies occurs.

The catalytic activity of the hydrogen ion is believed to be due to the formation of an oxonium salt of the lactonyl hydroxide group or its alkyl, corresponding anilide, etc., derivatives. That a di- or tri-basic, etc., oxonium salt is not the *active* salt in mutarotation by acids is shown by the fact that the increased velocity of the reaction is proportional to the first power of the concentration of the hydrogen ion instead of the second, third, etc., powers.

This theory has been extended to the Walden inversion, the rearrangement of such substance as δ and l menthone and many cases which logically follow as details of this theory.

S. F. ACREE: *On the Reactions of both the Ions and Molecules of Acids, Bases and Salts. A Reinterpretation of the Reactions of Sodium Methylate and Sodium Ethylate with 1, 2-Dinitrobenzene, 1, 2, 4-Dinitrochlorbenzene and 1, 2, 4-Dinitrobrombenzene.*

The data of Heclit, Conrad and Brueckner, and of Bruyn, Steger and Lulofs on the reactions of sodium methylate and sodium ethylate with aliphatic and aromatic alkyl halides and nitro derivatives can be reinterpreted on the basis of the writer's theory that both the ions and the molecules of acids, bases and salts are chemically active. When the reaction velocities obtained by these workers and our conductivity data are applied to our equation $K^N = K_i\alpha + K_m(1-\alpha)$ we se-

cure excellent constants for K_i and K_m, the activity of the ethylate or methylate ion, and the non-ionized sodium ethylate or methylate respectively.

G. D. Beal and H. F. Lewis: *Studies on Alkaloidal Salts. I. Strychnine Salts.*

Preliminary notice of the work being done at the University of Illinois, under the auspices of the Pharmaceutical Research Fund.

Methods of alkaloidal assay by the use of immiscible solvents are being studied. Salts of strychnine with tartaric, hydrochloric and sulphuric acid have been made and their solubilities investigated. Solvents used were ether, chloroform, water-saturated chloroform, alcohol and water. The distribution coefficient was determined using the formula $C'/C'' = d$, C' being the concentration of the salt in the chloroform layer, C'' the concentration of the salt in the aqueous layer. This was done with both neutral and acid solutions of the salt with chloroform.

C. S. Hudson and J. K. Dale: *A Comparison of the Optical Rotatory Powers of the Alpha and Beta Forms of Certain Acetylated Derivatives of Glucose.*

After careful purification, the alpha and beta forms of glucose pentacetate (molecular weight 390) were found to have the specific rotations $+102°$ and $+4°$, respectively, in chloroform. The corresponding alpha and beta forms of tetracetyl methylglucoside (m. w. 362) showed $(\alpha)_D^{20} = +131°$ and $-18°$. The *sum* of the molecular rotations of the alpha and beta forms is thus 41,300 for the glucose pentacetates and 40,900 for the tetracetyl methyl glucosides. The agreement conforms to theoretical considerations. The paper appears in full in the *Journal of the American Chemical Society.*

C. S. Hudson and J. M. Johnson: *The Isomeric Alpha and Beta Octacetates of Maltose and of Cellose.*

By heating the beta octacetate of maltose, of m.p. 159–60°, with acetic anhydride and zinc chloride, it was transformed to the new isomeric crystalline alpha maltose octacetate of m. p. 125°. The specific rotations in chloroform are $+122°$ for the alpha form and $+63°$ for the beta. After careful purification, the known alpha and beta octacetates of cellose show $(\alpha)_D^{20} = +41°$ and $-15°$, respectively, in chloroform. The *difference* of the rotations of the alpha and beta forms is thus 59° for maltose octacetate, 56° for cellose octacetate, and 57° has been found previously for the forms of lactose octacetate. From the rotation of the glucose pentacetates, the value 56° may be calculated. The four pairs of substances are thus in excellent agreement with theory. The paper will be published in full in the *Journal of the American Chemical Society.*

C. S. Hudson and J. K. Dale: *The Isomeric Pentacetates of Mannose.*

The expected form of mannose pentacetate has been prepared in a crystalline state by the method described in the preceding abstract. The new isomer melts at 64° and shows dextrorotation $(\alpha)_D^{20} = +55°$, in chloroform. Fischer found the beta pentacetate to melt at 117.5° and to show $(\alpha)_D^{20} = -25°$, in chloroform, which we have confirmed. The difference between the rotations of the two isomers is thus 80° in comparison with the value 98° found for the two forms of glucose pentacetate. Full paper will be published in the *Journal of the American Chemical Society.*

C. S. Hudson and H. O. Parker: *The Isomeric Pentacetates of Galactose.*

By the same method (see preceding) galactose pentacetate has been transformed to a crystalline isomer of m. p. 96° and specific rotation $+106°$ in chloroform. The new substance is evidently the alpha galactose pentacetate, since the earlier discovered form rotates $+23°$, and is thus the beta pentacetate. The difference between the rotations of the two isomers is 83°, which differs somewhat from the value in the case of the glucose pentacetate (98°), and agrees with the value found for the mannose pentacetates.

C. S. Hudson and D. H. Brauns: *Crystalline D-Fructose Pentacetate.*

By acetylating very pure fructose with acetic anhydride and sulphuric acid below 0°, a beautifully crystalline pentacetate of fructose has been prepared. It melts at 109–09° and shows levorotation $(\alpha)_D^{20} = -121°$ in chloroform. Paper in full will be published in the *Journal of the American Chemical Society.*

C. S. Hudson: *The Existence of a Third Pentacetate of Galactose.*

It is found that the acetylation of galactose with acetic anhydride and sodium acetate yields in addition to the well-known first pentacetate of the

sugar a fair amount (10 per cent.) of another crystalline substance melting at 98° and showing levorotation $(\alpha)_D^{20} = -41.6°$ in chloroform. Analysis shows it to be a new pentacetate of galactose. There are accordingly three isomeric forms of the pentacetate. Full paper to appear soon in the *Journal of the American Chemical Society.*

FRIEND E. CLARK and SAMUEL F. COX: *Some Derivatives of Chlor-methyl Ether.*

NORMAN A. DUBOIS: *Hop-seed Oil.*

CARL O. JOHNS: *Researches on Purines: On a New Synthesis of Purines. On 2-Oxy-8-Thiopurine, 2-Oxy-8-Methyl Mercaptopurines, 2-Oxy-8-Methyl Aminopurine and 2-Oxy-6-, 9-Dimethyl-8-Thiopurine.*

Mercaptopurines when treated with methylamine yield methyl-aminopurines and methyl mercaptan. The change of 2-oxy-8-methyl mercaptopurine into 2-oxy-8-methylaminopurine is offered in substantiation of this statement and the preparation of these products is described.

CARL O. JOHNS: *Researches on Thioamino Acids. On Thiohippuric Acid and Phthalyl-aminothioacetic Acid.*

Thiohippuric acid (m. p. 104°) was prepared from hippuryl chloride and potassium hydrogen sulfide. Upon hydrolysis with warm water hydrogen sulfide and hippuric acid resulted. With iodine in alkaline solution it gives dithiohippuric acid—a reaction characteristic of the thio acids. The anilide of hippuric acid is described.

Similarly, phthalyl-α-aminothioacetic acid was prepared from phthalylglycyl chloride and potassium hydrogen sulfide. It crystallizes from benzene in plates which melt at 112°. The anilide of phthalyl-α-aminoacetic acid is described.

B. G. FEINBERG: *Citral, and its Determination.*

C. G. DERICK: *The Preparation of Trimethylene Oxide.*

Since the commercial product "Blizzard" offers a cheap source for trimethylene glycol, trimethylene bromide was prepared in large quantities very cheaply from the action of 48 per cent. HBr with subsequent saturation with gaseous HBr; yields better than 90 per cent. being obtained. Trimethylene bromide heated to its boiling point with PbO gave monomolecular trimethylene oxide boiling at 52.3° under 745 mm. pressure. From the reaction flask a polymeric form of the oxide was isolated which boils at 183° under 55 mm. pressure.

Silver oxide acts with almost explosive violence upon the bromide if 100 grams of the latter is employed and only traces of the oxide are obtained.

Mercuric oxide appears to act best of all, giving mainly the monomolecular form.

C. G. DERICK and E. H. VOLLWEILER: *The Use of Trimethylene Oxide in the Grignard Reaction. The Synthesis of Normal Primary Hexyl Alcohol.*

The polymeric form of trimethylene oxide was treated with magnesium propyl bromide in ether solution. The reaction is fairly rapid, generating heat. Upon distillation with steam the *n*-primary hexyl alcohol distils and is extracted with ether from the aqueous layer saturated with potassium carbonate.

C. G. DERICK and R. W. HESS: *The Synthesis of γ-Acetylvalerianic Acid.*

Trimethylene bromide dissolved in absolute methyl alcohol is treated with one molecule of potassium cyanide. The γ-bromobutyronitrile formed is purified by fractional distillation under diminished pressure. Yield of pure product 25 per cent. It then condensed with acetoacetic ester and the resulting γ-cyanopropylacetoacetic ethyl ester is purified by distillation under 1 mm. pressure. Upon hydrolysis with 20 per cent. HCl it gives the desired acid.

C. G. DERICK and ST. ELMO BRADY: *The Ionization Constants of Certain Ketoparaffine Monobasic Acids.*

After careful preparation and purification the following acids have been measured by the conductivity with the following results: pyroracemic acid, $k_a^{22°} = 3.643 \times 10^{-3}$ (below 0.005ON); levulinic acid, $k_a^{22°} = 2.436 \times 10^{-5}$ and γ-acetylvalerianic acid, $k_a^{22°} = 2.295 \times 10^{-5}$.

The criterion "calculated Δ_0" shows these results to be accurate to one tenth of one per cent.

M. A. ROSANOFF and M. M. HARRISON: *On the Decomposition of Tertiary Amyl Esters.*

G. B. FRANKFORTER and LILLIAN COHEN: *Equilibria in the Systems of Methyl Alcohol, Ketones, Water and Inorganic Salts, Part I.*

G. B. FRANKFORTER and STERLING TEMPLE: *Equilibria in the Systems of Propyl Alcohols, Water and Salts.*

DIVISION OF PHARMACEUTICAL CHEMISTRY

F. R. Eldred, *chairman*
A. P. Sy, *secretary*

Wilbur L. Scoville: *The Stability of Nitroglycerin Tablets.*

Of 22 different lots of nitroglycerin tablets kept under observation 2½ to 3½ years, those made with a nitroglycerin paste (20 per cent. nitroglycerin absorbed in 80 per cent. sugar of milk) maintained their strength except the 1/150 gr. and 1/200 gr. tablets. All tablets made with an alcoholic solution of nitroglycerin deteriorated.

Deterioration may be due to one or both of two conditions; *i. e.*, a finer attenuation of the nitroglycerin when tablets are made from an alcoholic solution, or a more desirable isomeric form of the nitroglycerin as obtained in the paste form. Further experiments will be made to determine which factor may be the more important.

James H. Beal: *Some Reasons for the Variation Clause of the Food and Drugs Act.*

The United States Pharmacopœia appropriates titles devised and used in the arts and industries and attaches to them special meanings and standards which, though sufficient for pharmaceutical purposes, are not applicable to the arts and industries in which the greater proportion of chemical products are consumed. Only by virtue of the variation clause can these products be lawfully dealt in under their own names when they comply with other than pharmacopœial standards.

The variation clause is necessary to permit improvement of medicinal products in accordance with progress in pharmaceutical knowledge. Improvements are made in these products constantly. Without the existence of the variation clause such products could not be offered under their appropriate titles until after the improvements had been recognized by a revised pharmacopœia, which might be ten years distant.

The continuance of the variation clause as a part of the food and drug law is essential to reasonable freedom in industrial and pharmaceutical chemistry, and the demand for its unconditional repeal should be resisted.

Francis D. Dodge and Alfred E. Sherndal: *The Composition of Oil of Cassia.*

The authors have observed that oil of cassia contains a small amount of substances soluble in alkaline hydroxide solutions, and among these have identified salicylic aldehyde, coumarin, cinnamic acid, salicylic acid, benzoic acid, and an acid, not yet identified, apparently an unsaturated one, possibly of the acrylic series.

Though small in amount, salicylic aldehyde and coumarin undoubtedly participate in the composite aroma of the oil, and it is remarkable that their presence has not been previously observed.

H. A. Langenhan: *The Chemistry of the Daturas. II. The Alkaloidal Content of Datura Leaves.*

The study of the *Daturas* having been assigned by the Bureau of Plant Industry to its northern station at Madison as a special subject for investigation, the garden at Madison has in recent years raised, under the direction of G. A. Russell, the government expert, as many as fifteen to twenty species and varieties of *Daturas*. Much of the material thus produced has been assayed by the writer, and the results of the assays have recently been published as a Bulletin (No. 192) of the University of Wisconsin.

The collected results of all assays published by different experimenters seemed to show that little or nothing could be expected by working along old lines. Hence the cooperation of Professor Leon J. Cole, professor of experimental breeding in the College of Agriculture, and his assistant, Mr. C. M. Woodworth has been secured for a series of breeding experiments. As a result of last summer's work Messrs. Cole and Woodworth have germinated the collected seeds and are studying the results in the greenhouse. As in previous years, the writer has determined the alkaloidal content of the leaves of the plant studied by the breeders. The results thus obtained in greenhouse and laboratory will determine the selection of the seeds to be planted in the experimental garden this coming spring.

N. R. Mueller: *A Possible Explanation of the Reduction Phenomena Observed in Elixir of Phosphates of Iron, Quinine and Strychnine when Exposed to Light.*

By process of elimination the study of at least one of the basal problems has resolved itself to an investigation of the action of ferric iron in the form of hydroxide on citric acid under the influence of sunlight. Under these conditions the ferric iron is reduced to ferrous iron, at least in part, and goes into solution; a very small amount of the iron appears to be reduced to metallic iron, which is deposited in a very fine state of division. While the iron is reduced, the citric acid is oxidized in part with the formation of carbon dioxide. The colorless solution of iron salt or salts which thus results under the absolute exclusion of atmospheric oxygen becomes colored at once when exposed to the atmosphere, the solution turning greenish.

Charles L. Parsons, *Secretary*